English translation of the International Patent Application No. PCT/CH01/00682 "Device for connecting a longitudinal carrier to a bone fixation means" in the name of Synthes AG Chur

Device for connecting a longitudinal carrier to a bone fixation means

The invention relates to a device for connecting a longitudinal carrier to a bone fixation means, particularly a pedicle screw according to the generic term of Patent Claim 1.

Certain devices are already known from the state of the art for connecting pedicle screws to longitudinal carriers for fixing the vertebral column.

Such a connection device is disclosed in the US patent US 5,584,834 ERRICO. This well known invention comprises a device that allows a pedicle screw, or more generally a bone anchoring element, to be connected in a simple way to a longitudinal carrier. The connection device generally consists of a cylindrical central body, which is provided at its lower end with a slotted, externally conical collet chuck with a hollow-spherical cavity for receiving a spherical head of a bone anchoring element and has an external thread at its upper end. In its central section, this central body is provided with a hole open on the side and running perpendicular to its central axis for receiving a longitudinal carrier. A lower shell with an inner cone corresponding to the cone of the central body and an upper shell with a passage opening open towards the lower shell are pushed over this central body. When in assembled state, both shells can be pressed downward by means of a nut, which can be screwed over the external thread on the central body. The longitudinal carrier is inserted between the lower and upper shell, which is conducted through the passage opening in the upper shell on the side. When the connection device is blocked, the upper shell is pressed downwards when this nut is tightened, which presses the longitudinal carrier inserted in the passage opening onto the lower shell, the inner cone of which as a result is shoved over the external cone of the collet chuck. When the cones are thus pressed onto each other it leads to the collet chuck being compressed and thus the spherical head tensioned within the collet chuck being blocked. The disadvantage of this prior art device is, on the one hand, the significant construction height of the connection element due to the connection in the form of a socket-joint between the spherical head of the bone anchoring element and

the collet chuck and, on the other hand, the space required for the surgical instrument for tightening the nut to be screwed over the external thread on the central body.

The invention is intended to remedy this situation. The invention is based on the task of creating a device that requires as little space as possible and can additionally be implanted with a minimum requirement for surgical instruments and operations. It should specifically be possible to insert a surgical instrument with a diameter not larger than the diameter of the implant so that as little damage as possible is caused to the surrounding tissue parts.

The invention solves the set task with a device for connecting a longitudinal carrier to a bone fixation means, specifically a pedicle screw which has the features of Claim 1.

The device according to the invention essentially comprises a connection element with a sealing cap and a tensioning means. The connection element is provided with a cavity coaxial to the central axis, which is open at the upper and at the lower end of the connection element. The cavity is tapered towards its lower end of the connection element by means of a shoulder. A channel that is open at the upper end of the connection element and running transverse to the central axis of the connection element penetrates the connection element diametrically, with the result that, for example, a longitudinal carrier representing a vertebral fixation system can be received in the channel and runs orthogonal to the central axis, whereas a bone fixation means, for example a pedicle screw can be conducted through the cavity parallel to the central axis, until the screw head of the pedicle screw is arrested axially by the shoulder in the cavity. The sealing cap is provided with a second channel, which is also arranged transverse to the central axis and is open towards the front end of the sealing cap, wherein the longitudinal carrier is received at the sealing cap installed on the connection element. This second channel means that the sealing cap is divided from its front end to the base of the second channel in two segments elastically deformable transverse to the central axis. The tensioning means can be connected to this at the rear end of the sealing cap and serves to block a longitudinal carrier and a bone fixation means in the connection element. For securing the sealing cap to the connection element arresting means latching into each other are arranged complementary to each other on the connection element and in the cavity of the sealing cap.

In the preferred embodiment of the device according to the invention, the arresting means are arranged on the periphery of the connection element and also at the periphery in the cavity in the sealing cap. The arresting means preferably consists of bulges on the connection element and the complementary depressions in the cavity of the sealing cap.

In another embodiment of the device according to the invention, the shoulder that narrows the cavity at the front end of the sealing cap comprises a planar bearing surface. This bearing surface is used as a support, for example, for the screw head of a pedicle screw. Instead of the planar design, this bearing surface can also be designed in spherical form or having several concentric steps.

Further advantageous embodiments of the invention are indicated in the dependant claims.

The advantages achieved by the invention can be seen essentially in that due to the device according to the invention:

- very low structural height of the connection element with sealing cap can be achieved;
- the device can be blocked during the implant operation by means of a single locking mechanism; and
- instruments can be used that have a diameter less than the implants, which means there is now no need for any large access that can traumatise the patient and the device is accordingly ideal for minimum invasive or navigated surgery. These implants also offer a possibility of treating patients in cases of thorascopic access.

In a further embodiment the device according to the invention comprises securing means by means of which the cavity in the connection element is narrowed between the rear end of the bone head and the upper end of the connection element. This prevents the bone fixation means in the connection element from falling out at the upper end of the connection element.

This embodiment design with securing means provides the advantage that pre-assembled implants are used which means loss of time in the operation theatre can be avoided and the risk potential, for example through mixing up or incorrect insertion is significantly reduced.

The invention and further developments of the invention are described in more detail below on the basis of partially schematic illustrations of several embodiments.

Fig. 1 shows a longitudinal section through the preferred embodiment of the device according to the invention;

Fig. 2a shows a view of the connection element of the embodiment of the device according to the invention illustrated in Fig. 1;

Fig. 2b shows a view of the embodiment of the device according to the invention illustrated in Fig. 1;

Fig. 3 shows a section through another embodiment of the device according to the invention;

Fig. 4 shows a view of the embodiment of the device according to the invention illustrated in Fig. 3;

Fig. 5 shows a section through a further embodiment of the device according to the invention; and

Fig. 6 shows a section through a further embodiment of the device according to the invention.

Fig. 1 illustrates a bone fixation means 1 designed as pedicle screw together with a connection element 5, a longitudinal carrier 11, a sealing cap 12 shoved coaxially over the connection element 5 from its upper end 6 and a tensioning means 13 connected to the sealing cap 12. The front segment 3 of the bone fixation means 1 is designed as a screw shaft 24 with external thread 26, whereas the rear segment 4 is designed as a

circular-cylindrical screw head 30. The bone fixation means 1 designed as pedicle screw can be screwed into a pedicle by means of the external thread 26 on the screw shaft 24, wherein a screwdriver (not illustrated) can be inserted in the means 29 illustrated as a hexagon socket for receiving a screwdriver, which are arranged at an end position on the screw head 30. Instead of a design as hexagon socket, the means 29 for receiving a screwdriver can also be designed as, for example, hexagon socket, Torx or Phillips.

The connection element 5 consists of a hollow body coaxial to the central axis 2 with an upper end 6 and a lower end 7. The diameter of the cavity 8 in the connection element 5 is tapered at the lower end 7, which forms a shoulder 9 with a bearing surface 25, on which the screw head 30 of the bone fixation means 1 can be placed. The screw shaft 24 of the bone fixation means 1 can be passed through the cavity 8 tapered at the lower end 7 of the connection element 5. The connection element 5 is furthermore penetrated vertically to the central axis 2 by a first channel 10, wherein this first channel 10 is open towards the upper end 6 of the connection element 5. The depth of the channel 10 measured from the upper end 6 of the connection element 5 parallel to the central axis 2 is designed in such a way that a longitudinal carrier 11 inserted in the channel 10 can be placed at an end position on the screw head 30 of the bone fixation means 1. The sealing cap 12 is pushed over the connection element 5, wherein the front end 20 of the sealing cap 12 is directed towards the lower end 7 of the connection element 5 and the connection element 5 is partially received parallel to the central axis 2 in the second cavity 18 provided in the sealing cap 12. The second channel 17 penetrating the sealing cap 12 vertical to the central axis 2 enables the acceptance of the longitudinal carrier 11 laid in the connection element 5 in the first channel 10 to be received in the sealing cap 12. The second channel 17 is open at the front end 20 of the sealing cap 12 with the result that the sealing cap 12 in the case of longitudinal carrier 11 inserted in the connection element 5 can be pushed over the connection element 5 parallel to the central axis 2.

When viewed parallel to the central axis 2, the arresting means 21 are designed as bulges 15 attached peripheral to the connection element 5 and complementary depressions 16 attached peripheral in the second cavity 18 of the sealing cap 12. The arresting means 21 are arranged in the same design on two axial levels which means

that different latch positions are possible. The first latch position is used preferably for repositioning the bones or bone fragments to be fixed, whereas the second or further latch positions are used for fixation of the device.

The bulges 15 and the depressions 16 are provided with a saw-tooth shaped profile in a cross section surface parallel to the central axis 2, wherein the steep flanks of the bulges 15 are oriented towards the lower end 7 of the connection element 5 and the steep flanks of the depressions 16 are oriented towards the rear end 19 of the sealing cap 12. If the sealing cap 12 is shoved over the connection element 5 parallel to the central axis 2, the two segments 27;28 (Fig. 2b) of the sealing cap 12 formed by the second channel 17 are resiliently spread transverse to the central axis 2, with the result that the sealing cap 12 can be shoved over the bulges 15 on the connection element 5 until the depressions 16 in the second cavity 18 cover the bulges 15 and the two segments 27;28 (Fig. 2b) on the sealing cap 12 elastically lock towards the central axis 2.

The tensioning means 13 are provided in the form of a locking screw that can be screwed into the internal thread in the hole 31 at the rear end 19 of the sealing cap 12 coaxial to the central axis 2.

Fig. 2 shows the connection element 5 from the perspective of the upper end 6. The cavity 8 and the arresting means 21 are arranged concentrically to the central axis 2 (Fig. 1), wherein the arresting means 21 is configured in the form of bulges 15 that are, when seen parallel to the central axis 2, arranged peripheral on the connection means 5. The ring-shaped side wall of the connection element 5 and the bulges 15 are interrupted by the channel 10, wherein the channel axis 14 runs vertical to the central axis 2 (Fig. 1).

The longitudinal carrier 11 is inserted in the channel 10. In addition, the channel 10 on the connection element 5 forms two tongues 22;23 on a section of its length, wherein the bulges 15 are provided only at these two tongues 22;23 and do not surround the entire connection element 5.

Fig. 2b shows the sealing cap 12 assembled with the connection element 5 and the tensioning means 13. The second channel 17 penetrates the sealing cap 12 on one section of its length vertical to the central axis 2 (Fig. 1), with the result that two segments 27;28 are formed on the sealing cap 12, which resiliently spread radially when the sealing cap 12 is pushed over the connection element 5, which allows the sealing cap 12 to be pushed over the bulges 15 (Fig. 1). As soon as the sealing cap 12 is pushed far enough over the connection element 5 so that the depressions 16 (Fig. 1) are able to engage with the bulges 15 (Fig. 1), the two segments 27;28 will narrow elastically back, i.e. towards the central axis 2 (Fig. 1).

The embodiment of the device according to the invention illustrated in Fig. 3 and Fig. 4 differs from the embodiment illustrated in Fig. 1 and 2 only in that the sealing cap 12 is provided with two slots 34 orthogonal to the second channel 17, which are inserted into the wall of the sealing cap 12 from its front end 20. Instead of the two segments 27;28 (Fig. 2b), the sealing cap 12 in this embodiment is provided with four segments 27;28;32;33. This means that the elasticity of the sealing cap 12 can be increased and this cap can be shoved more easily over the bulges 15 on the connection element 5.

For implanting the device, the pre-assembled implant comprising the bone fixation means 1 and the connection element 5 is removed from the implant container with a screw driver inserted in the means 29, without any need for a further instrument for holding the parts and without the surgeon having the join the parts together. Then, the implant which provisionally consists only of bone fixation means 1 and a connection element 5 is screwed into the prepared pedicle. After the longitudinal carrier 11 is laid into the first channel 10 arranged in the connection element 5, the same screwdriver is used to remove again the pre-assembled sealing cap 12 provided with the tensioning means 13 from the implant container, in which operation there is again no need for a special holding instrument. By means of a special clamp, the sealing cap 12 is locked in the first latch point, i.e. when the first depression 16 in the sealing cap 12 has been pushed over the first bulge 15 on the connection element 5. After repositioning is completed, the sealing cap 12 is placed in the second or third latch position and locked. The tensioning means 13 is then tightened by means of the screwdriver and the longitudinal carrier 11 inserted in the first channel 10 is blocked in the connection element 5. When the tensioning means 13 is being tightened, the longitudinal carrier 11

is pressed onto the bone head 30 with the result that this is clamped between the shoulder 9 and the longitudinal carrier 11 and the bone fixation means 1 together with the longitudinal carrier 11 is blocked in the connection element 5.

Fig. 5 illustrates an embodiment of the device according to the invention that differs from the embodiments described above only in that the screw head 30 of the bone fixation means 1 is secured by means of a securing means 35 from driving out of the cavity 8. The securing means 35 comprises a pin 37 that is pressed, for example, in a hole 38 running transverse to the central axis 2 and extends into the cavity 8. The hole 38 is arranged axially between the rear end 41 of the bone head 30 and the upper end 6 of the connection element 5. Instead of a hole 38, several holes 38 spread across the width and several pins 37 can also be provided as securing means 35.

Fig. 6 shows an embodiment of the device according to the invention wherein the securing means 35 is carried out by a snap ring 39 instead of by one or several pins 37. The snap ring 39 is received in a groove 40 positioned at the rear end 41 of the screw head 30 and protrudes into the cavity 8 so that the cavity 8 is tapered there towards its upper end 6. The groove 40 is arranged axially in such a way that the snap ring 39 inserted therein does not exceed the rear end 41 of the screw head 30 towards the upper end 6 of the connection element 5, which means that the longitudinal carrier 11 does not lie on the snap ring 39. The screw head 30 is for this purpose designed, for example, reduced at its rear end 41 and is provided at this rear end 41 with an axial segment 42 which has a diameter smaller than the bone head 30. The shoulder 43 formed by this segment 42 with reduced diameter will then be brought in contact with the securing device 35 provided here in the form of a snap ring 39, so that the screw head 30 can be arrested against axial movements towards the upper end 6 of the connection element 5 by the snap ring 39 in the cavity 8. The segment 42 of the screw head 30 passes through the ring-shaped opening of the snap ring 39 and protrudes at the end beyond the snap ring 39, so that the longitudinal carrier 11 can rest at the rear end 41 of the screw head 30.